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PROFILE OF AN EFFECTIVE ENGINEERING MANAGER

BY
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December, 1991

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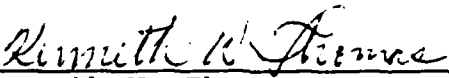
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ABSTRACT

This study was designed to investigate the behavioral factors that determine the effectiveness of branch engineering managers at the Naval Avionics Center (NAC) in Indianapolis. Data were collected using a survey designed especially for this study. Ratings of effectiveness variables were obtained from both engineers (subordinates) and the division manager (superior) for each branch manager. Correlations were run between these effectiveness variables and specific managerial behaviors as rated by engineers in each branch. Somewhat different sets of behaviors or "critical skill areas" were found to be related to three different sets of effectiveness variables. A composite picture highlights the importance of the branch managers' communication activities and identifies four communication functions crucial to the effectiveness of the branch manager. These functions are 1) Listening and Responding to Branch Managers, 2) Providing Guidance to Branch Members, 3) Encouraging Collaboration Among Branch Members, and 4) Communicating the Needs of the Branch. This empirical data can be used as input for designing management development programs, selecting engineering managers, and conducting performance appraisals.

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PROFILE OF AN EFFECTIVE ENGINEERING MANAGER

The effective management of professionals is a crucial issue for many organizations. Professional workers, often referred to as "knowledge workers," play key roles in organizations. In an information-based society, these professionals are a scarce and valuable resource. They are costly to hire, train, and replace. Therefore, understanding the complexities of managing professionals is vital. In regard to these professional workers, what, then, is an effective manager?, and what managerial behaviors determine the effectiveness of a manager?

This study was designed specifically to investigate the behavioral factors that determine the effectiveness of engineering managers at the Naval Avionics Center (NAC) in Indianapolis. This study provides empirical data about the effectiveness of the engineering managers at NAC that can provide potential input for designing management development programs, selecting engineering managers, and conducting performance appraisals. In addition, the results of this study may provide a basis for generalizing to managers of engineers or other professionals in other settings.

The remainder of this report will briefly describe the existing literature on engineering managerial effectiveness, explain the methods used in the study, report the findings, and finally discuss the implications of our findings.

OVERVIEW OF EXISTING LITERATURE

Researchers of this topic have frequently observed that engineers are trained in technical skills and are often promoted to managerial positions primarily for their technical abilities. Oftentimes this transition to management is difficult because the requisite skills for a successful engineer may be quite different than those required for an effective engineering manager. On the one hand, research shows that engineers tend to be more interested in things and data than in people. They are more often found to be task oriented and focused on finding solutions to logical problems (Holder, Shultz & Friel, 1984). In contrast, the engineering manager must possess not only technical expertise, but also administrative skills, managerial skills, and interpersonal skills. No shortage of opinion exists regarding the behaviors and skills that are required for an engineering manager. A review of the literature provides a variety of different lists of behaviors and skills (Bawady, 1981; Evans & Bredin, 1987; Giegold, 1982; Mandt, 1984; Morrison, 1986; Thamhain, 1983; and Zachary, 1984.) However, each author's list is different, and most of the lists are too long to be useful. Furthermore, very little of the literature is empirically based.

We began our study by reviewing the opinions of authors in the existing literature and getting the opinion of several NAC engineers and managers about what makes engineering managers effective. But our study goes further by testing these opinions to identify specific skills and behaviors that are actually related to

measures of effectiveness in this organization. Moreover, in the process of conducting this study, we have tried to capture the complexity of managerial effectiveness by employing multiple measures of effectiveness.

METHODS

The first phase of the study included selecting the participants, conducting in-depth interviews with engineering managers and engineers, designing the study, and developing the questionnaires.

PARTICIPANTS

Engineers, scientists, and engineering managers who participated in this study were from the 800 (Systems Technology) and 900 (Systems and Engineering) departments. These two departments were chosen because they contain the largest concentration of engineers in the Naval Avionics Center. Furthermore, engineers in these two departments constitute a relatively homogeneous study population in that they perform project engineering work.

These engineers and scientists (hereafter referred to as engineers) are organized into branches. The managers of these branches were the focus of our study. Data relating to these branch managers were collected both from engineers in the branch and from the division manager to whom the branch manager reported.

PRELIMINARY INTERVIEWS

Semi-structured, confidential interviews of 29 NAC engineering managers and engineers were conducted. Each interview lasted from

30 to 60 minutes. The following is a breakdown of the personnel interviewed:

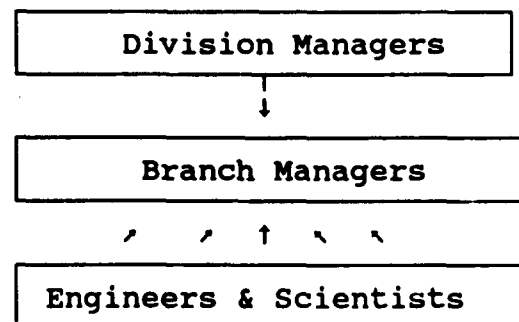
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| * 2 Department Heads | * 5 Branch Managers |
| * 5 Division Directors | * 19 Engineers |

The main purpose of these interviews was to generate a list of criteria for identifying effective engineering managers at the Naval Avionics Center and to identify aspects of managerial behavior believed to make engineering managers more effective in this organization. These criteria and behaviors were used, along with findings from the literature review, to design questionnaires for the main part of the study. Appendix A includes a list of characteristics of effective engineering managers mentioned by at least two interviewees.

BASIC DESIGN OF THE STUDY

In this study, ratings of a branch manager's behavior were collected by questionnaire from engineers within that branch. Ratings of effectiveness were obtained from both the engineers and the division manager for each branch manager. (See Figure 1).

FIGURE 1
Sources of Effectiveness Data



Combining this information, then, allowed us to determine how effective branch managers behave toward their engineers. Originally, we had intended to collect effectiveness ratings from peers (other branch managers) as well. However, preliminary interviews indicated that branch managers within a division did not interact enough to be able to rate each other. The following section describes the engineers' and division managers' questionnaires.

QUESTIONNAIRE DISTRIBUTION AND RESPONSE RATE

The questionnaire items for the engineers were based upon the literature review and preliminary interviews. Specific questionnaire items (questions) were either written as original items or taken from previous studies. The survey questions relevant to this report were: 1) ratings of specific branch manager behaviors and 2) ratings of variables used to indicate effectiveness (e.g. group climate, job satisfaction, intention to turnover, motivation).

Division managers received questionnaires that asked them to rate branch managers' effectiveness, using the organization's Performance Management Recognition Systems (PMRS) Critical Elements. The division managers also rated branch managers on their overall managerial effectiveness. Engineers and division managers reported their ratings using a 7-point scale where 1 indicated a low rating and 7 a high rating. (Copies of the questionnaire are available from the researchers.)

The questionnaires were distributed by the Civilian Personnel Department (Code 500) to engineers and division managers in the 800 and 900 departments. The questionnaires were completely confidential. A total of 556 questionnaires were given to engineers in these departments. Of these 556 questionnaires, 389 were returned, a 69% response rate. Eleven questionnaires were distributed to the division managers of which 9 were returned, an 82% response rate.

ANALYSIS AND FINDINGS

The first step of our analysis was to identify the key effectiveness variables. Second, correlations were examined between these effectiveness variables and engineers' ratings of 64 specific aspects of their branch manager's behaviors. The purpose of this second analysis was to see which behaviors are most related to effectiveness in this organization. These behaviors were then designated as key skill areas for engineering managers.

CHOOSING EFFECTIVENESS MEASURES

As noted earlier, effectiveness measures were derived from division managers' ratings of the branch managers as well as the engineers' ratings of their respective branch manager. Correlations among the division managers' effectiveness ratings were found to be generally strong, indicating a single effectiveness factor. For the purpose of this study, the division manager's rating of the overall effectiveness was selected as the most straightforward measure of the branch manager's effectiveness. The mean for this

overall effectiveness rating was 4.28 on a 7-point scale, with a standard deviation of 1.09.

For the engineers' rating of the branch manager's effectiveness, the general strategy was to identify a small number of variables that were relevant measures of effectiveness for this study. (For detailed discussion of this analysis see Chang & Quick, 1991). As a result of this selection process, the following four effectiveness variables were chosen from the engineers' data:

Overall Managerial Effectiveness - A general evaluation of the branch manager's effectiveness. Three items were used to rate satisfaction with the manager, satisfaction that his or her leadership style was appropriate, and the overall effectiveness of the branch manager.

Job Satisfaction - Four items were included in this variable which has to do with how well the job measured up to the engineer's expectations, satisfaction with the job, satisfaction with the kind of work done, and whether the engineer would take the job again.

Intrinsic Task Motivation - This variable deals with the rewards that the engineers received from the work itself rather than extrinsic rewards such as pay and promotions. Twenty-nine items were used to measure this variable. (See Sutz (1991) for a detailed report of the analysis of intrinsic task motivation in this setting).

Positive Working Climate - This variable measured the engineers' positive feelings about the work environment among engineers in the branch. Twenty items were used to rate such perceptions as commitment to group tasks, level of supportiveness for group members, receptiveness to new ideas and confidence in the group's ability.

Mean scores and standard deviations for these effectiveness variables are shown for the 800 and 900 departments in Table 1, as well as the entire organization. (No statistically significant differences were found between the two departments.) All effectiveness variables were found to have mean ratings of greater

than 4.4, showing a positive evaluation in all categories. The highest rating is intrinsic task motivation ($\bar{X}=5.32$) and the lowest is job satisfaction ($\bar{X}=4.4$).

Table 1
MEAN¹ RESPONSES FOR ENGINEERS' RATINGS OF
EFFECTIVENESS VARIABLES
(Each Department and Overall)

Effectiveness Variables	800 Dept (n=23 branches)	900 Dept (n=25 branches)	Overall (n=48 branches)
Overall Managerial Effectiveness	5.22 (.79) ²	4.79 (1.09)	4.99 (.97)
Intrinsic Task Motivation	5.33 (.36)	5.30 (.51)	5.32 (.44)
Positive Working Climate	4.86 (.50)	4.77 (.48)	4.81 (.49)
Job Satisfaction	4.39 (.57)	4.49 (.71)	4.44 (.64)

¹Means are based on a scale of 1-7, 1=low ratings, 4=midpoint, and 7=high ratings on each variable

²Standard deviations are presented in parentheses

The correlations among these four effectiveness variables show a strong relationship, indicating that branch managers who are rated as more effective by engineers tend to have branches with a more positive working climate and that engineers in their branches tend to have higher intrinsic motivation and job satisfaction. (see Appendix B)

In summary, a total of five effectiveness variables were chosen for this study--one measure of overall effectiveness from

the division manager and four measures from the engineers within the branches (overall effectiveness, intrinsic task motivation, positive working climate, and job satisfaction).

IDENTIFYING KEY SKILLS AREAS FOR MANAGERIAL EFFECTIVENESS

Sixty-four questionnaire items representing engineers' ratings of managerial behaviors were correlated with the five effectiveness variables selected in the previous analysis--the division managers' overall rating of the branch managers' effectiveness and the four effectiveness measures as rated by the engineers. (See Appendix C for the managerial behavior items rated by the engineers, along with means for these items.)

Correlations between the effectiveness measures derived from engineers and the 64 items measuring managerial behaviors were, for the most part, high. In fact, subsequent analysis of the engineers' ratings of managerial behaviors showed a "halo effect" among the items. In other words, when an engineer rated a branch manager "high" in overall effectiveness, he or she tended to rate the manager "high" on many other items. Rather than list all the behavioral items correlating with an effectiveness measure, we focused on the 10 items with the strongest correlations with that measure. This analysis sought to identify key managerial skills that were most strongly correlated to that measure of effectiveness and which, therefore, explained the most variance in that measure of effectiveness.

This analysis revealed three general sets of managerial behaviors (skill areas), each related to different effectiveness measures:

SKILL AREAS	EFFECTIVENESS MEASURES
1. Guidance and Responsiveness	Engineers' ratings of branch manager's overall effectiveness
2. Managing the Branch System	Engineers' ratings of "quality of work life" variables: intrinsic task motivation, group climate, and job satisfaction
3. Teamwork Toward Organizational Goals	Division managers' rating of branch managers' overall effectiveness

Each of these skills areas highlights a different theme involved in effective management. However, there is also some overlap among these skill areas. We will first discuss the three skill areas separately. Then we will present the composite picture that emerges when we combine all the managerial behaviors identified as key skills.

Skill Area 1. Guidance and Responsiveness. Table 2 shows the 10 managerial behaviors that correlated most strongly with subordinates' overall evaluation of the manager. These managerial behaviors tended to deal primarily with direct interpersonal relations between the manager and the engineer--with how the manager interacts with and treats the subordinate. Managerial effectiveness was highly correlated with behaviors related to providing guidance and responsiveness to subordinates.

Table 2

SKILL AREA 1: GUIDANCE AND RESPONSIVENESS
(Managerial Behaviors Most Strongly Correlated with
Engineers' Rating of Overall Managerial Effectiveness)

<u>Managerial Behavior</u>	<u>Correlations</u>
Guidance	
Lets us know the significance of what we are doing (MB10)	.90
Provides a sense of direction for this branch (MB49)	.88
Provides helpful feedback (MB57)	.88
Is an effective teacher (MB64)	.88
Pushes ahead in a positive manner (MB38)	.87
Gives subordinates clear guidance (MB61)	.86
Responsiveness	
Treats me with respect (MB30)	.86
Implements subordinate's ideas (MB51)	.86
Gives us credit for our successes (MB66)	.86
Is sensitive to my needs and desires (MB9)	.85

As shown in Table 2, correlations of these behaviors with the engineers' overall evaluation of the manager are quite high. The engineers' overall evaluation of their manager can be viewed as a general rating of their approval or liking of their boss, which is at the heart of the halo effect observed in the engineers' ratings. What our findings appear to show is that this general evaluation seems most directly associated with the manager's guidance and responsiveness.

Providing the proper combination of guidance and consideration is the central topic in the research literature on leadership style. The work of Fiedler (1965), The Ohio State Studies (1979), and Hersey and Blanchard (1982) are examples of research in this area. This first skills area, therefore, seems to get at this question of leadership style.

Skill Area 2. Managing the Branch System. The managerial behaviors most strongly related to Intrinsic Task Motivation, Positive Working Climate, and Job Satisfaction show a great deal of overlap. Hence, these three effectiveness variables seem related to a common skill area. All three of these effectiveness variables capture important facets of the engineers' Quality of Work Life--the satisfaction that the engineers derive from their own work (Intrinsic Task Motivation), their job (Job Satisfaction) and their branch work group (Positive Working Climate).

Table 3 lists the ten managerial behaviors that correlated most highly with these three effectiveness variables. These behaviors are the ones that occurred in the top 10 of at least two of these three variables. (See Appendix D for managerial behaviors associated with each of the three variables, separately.)

Table 3

SKILL AREA 2: MANAGING THE BRANCH SYSTEM
(Managerial Behaviors Most Strongly Correlated with
Engineers' Intrinsic Task Motivation,
Positive Working Climate and Job Satisfaction)

<u>Managerial Behaviors</u>	<u>Average Correlations with the three Effectiveness Variables</u>
Buffers and Protects the Branch	
Runs interference for us in dealing with top management and other units (MB37)	.64
Protects the branch from unnecessary hassles and interruptions (MB20)	.53
Makes Informed Personnel Decisions	
Assigns work equitably (MB39)	.57
Assigns career development opportunities based on individual performance (MB25)	.55
Assigns tasks and projects appropriately, based on subordinates' skills and limitations (MB22)	.53
Guides subordinates' career development (MB18)	.53
Gives recognition for superior performance (MB29)	.50
Work Facilitation	
Implements subordinates ideas (MB51)	.52
Keeps us on schedule (MB19)	.50
Promotes teamwork (MB60)	.50

The ten managerial behaviors in Table 3 are associated with how the manager uses authority or position to "run the system." They deal with buffering and protecting the branch, making informed personnel decisions, and facilitating work within the branch. These skills are described in further detail:

Buffering and Protecting the System - Branch managers must do more than relay directives from top management. The branch manager must negotiate for the needs of the branch and represent the engineers' legitimate work needs to the rest of the organization.

Making Effective Personnel Decisions - This skills subarea requires achieving fit between the engineers and the tasks, providing appropriate development programs, and recognizing superior performance. Branch managers need to find out the skills, limitations, and accomplishments of each engineer and then make personnel decisions accordingly.

Work Facilitation - The branch manager aids the efforts of engineers in the branch by helping them work together, implementing their ideas, and keeping them on schedule.

Our findings regarding this skill area indicate that the satisfactions experienced by engineers depend most strongly on these aspects of how well their manager runs the branch system. These skills appear to provide key enabling conditions that allow engineers in the branch to perform well (individually and in a group) and derive satisfaction from this performance.

Skill Area 3. Building Teamwork Toward Organizational Goals.

Table 4 lists the ten managerial behaviors that correlated most strongly with the division managers' rating of the branch managers' overall effectiveness. Recall that these managerial behaviors are rated by the engineers, not the division manager. So, these

correlations show how the branch managers who are rated most effective by their bosses look to their subordinates.

Table 4

SKILL AREA 3: BUILDING TEAMWORK TOWARD ORGANIZATIONAL GOALS
(Managerial Behaviors Most Strongly
Correlated with Division Managers' Rating of
Overall Effectiveness)

<u>Managerial Behavior</u>	<u>Correlations</u>
Teamwork Skills	
Fosters open communication	
Listens to subordinates (MB24)	.51
Is straightforward and candid (MB3)	.47
Emphasizes Cooperation	
Promotes teamwork (MB6)	.49
Emphasizes cooperation between branch members (MB36)	.40
Trusting, Not Critical	
(Not) Critical of subordinates (MB4)	-.45
Trusts subordinates (MB60)	.50
(Does not) Tell us why things can't be done (MB62)	-.44
Treats me with respect (MB30)	.41
Goal Clarity	
Emphasizes customer needs (MB38)	.45
Is able to prioritize tasks effectively (MB50)	.41

These managerial behaviors deal mostly with teamwork skills and clarity regarding organization goals. Division managers rating

of branch managers correlated highly with behaviors relating to open communication, trust, and cooperation. Additionally, effectiveness was correlated with an ability to prioritize tasks and emphasize customer needs. Thus, the division managers seem to focus on the branch manager's ability to get the branch to work as a team towards the organization's goals.

THE COMPOSITE PICTURE

The preceding section has identified three sets of skills that are most strongly related to different effectiveness variables. In this section, we will try to put these skills together into a composite picture of the effective engineering manager. Taken together, what do the survey results indicate about the overall pattern or profile of skills that make the most difference in managerial effectiveness?

One conclusion that emerges from our results is that management effectiveness is not a matter of learning any single principle of management. It is not, for example, a matter of being a "hands-off" manager, or learning to delegate (frequent responses in preliminary interviews). Rather, effectiveness is related to a complex set of behaviors. This recognition of complexity is consistent with current trends in the broader management literature (e.g., Whetton & Cameron, 1991; Quinn, 1988).

Running through this complexity, however, a strong theme was apparent to our research team--the vital importance of the communication activities performed by the branch manager. Most of the managerial behaviors that were most strongly related to a

manager's effectiveness have to do with communication and coordination. Interestingly, "good communicator" was also the phrase that came up most frequently with the division managers and engineers during the initial interviews. But the phrase "good communicator" is too abstract to be useful. What our survey results appear to do is to identify the key communication functions that make the biggest difference in managerial effectiveness, and to point out the complexity of the communication requirements for the branch manager.

First, let us describe the general portrait of the branch manager's task environment that has emerged from our interviews and discussions at NAC. The branch manager is one key actor in a highly interdependent network of organization members, virtually all of whom want to perform effectively. The branch engineers, for example, have high intrinsic motivation to perform their jobs well (Sutz, 1991). However, the very notion of what is effective performance has some inherent ambiguity or uncertainty for actors in the organization. Performance is judged as effective when it achieves a set of needs, within some set of constraints and abilities. The problem is that bits of knowledge about needs (of customers, top management, the branch, and individual engineers) are located in different parts of the network, as are knowledge about constraints, abilities, and ongoing performance. In addition, these needs, etc., are subject to frequent change as conditions change. In this setting, then, there is a premium on getting

actors at all levels the current information most relevant to guiding their performance.

Against this task background, our results serve to identify the crucial importance of different communications functions performed by the branch manager. To help show this, we have taken the managerial behaviors (skills) most strongly related to the effectiveness variables, and reorganized them in terms of four communications functions (see Table 5). These functions are: (1) listening and responding to information from branch members; (2) providing guidance to branch members; (3) encouraging collaboration; and (4) communicating the needs of the branch to upper management.

(1) LISTENING AND RESPONDING TO BRANCH MEMBERS

To be able to pass on (or to act upon) information, effective managers must first be able to elicit and hear information. Thirteen behaviors in Table 5 have to do with listening to branch members and/or responding to them. With respect to listening, effective managers listen to branch members' needs and ideas, and help elicit ideas by not being critical or otherwise negative. Here the effective manager's manner is described in terms of trust, respect, sensitivity, positiveness, and being non-critical. Beyond listening to branch members, effective managers also take the next step by acting upon and acknowledging (responding to) the information they have received from those branch members. This responsiveness shows up as implementing sound ideas, giving credit

Table 5

KEY SKILLS IDENTIFIED BY THIS STUDY,
ORGANIZED BY COMMUNICATION FUNCTIONS

Listening and Responding
to Branch Members

Listening

Listens to subordinates
Is sensitive to my needs and desires
Trusts subordinates
Treats me with respect
(Not) Critical of subordinates
(Does not) Tell us why things can't be done
Pushes ahead in a positive manner

Responding

Implements subordinates' ideas
Gives us credit for our successes
Gives us recognition for superior performance
Assigns career development opportunities based
on individual performance
Assigns tasks and projects appropriately, based
on subordinates' skills and limitations
Assigns work equitably

Encouraging Collaboration Among
Branch Members

Promotes teamwork
Emphasizes cooperation between
branch members

Providing Guidance to Branch Members

To the branch as a whole:

Provides a sense of direction
Is able to prioritize tasks effectively
Lets us know the significance of what we do
Emphasizes customer needs
Keeps us on schedule

To individuals:

Gives subordinates clear guidance
Is straightforward and candid
Provides helpful feedback
Is an effective teacher

Communicating the Needs
of the Branch

Runs interference for us in dealing with
top management and other units
Protects the branch from unnecessary
hassles and interruptions

and recognition for performance, and assigning work tasks and career development opportunities based upon performance. Among other things, this responsiveness serves to further clarify branch members' notions of effective performance.

(2) PROVIDING GUIDANCE TO BRANCH MEMBERS

Branch managers' experience and contacts with others outside the branch (including upper management), place them in key positions for providing needed guidance to branch members. Ten behaviors shown in Table 5 involve this guidance.

Notice that providing effective guidance in this setting is not a matter of giving orders. Rather, it seems to involve providing engineers with information that is helpful in guiding their efforts. Likewise, it is clear that effective managers do much more than simply pass on facts. Most of these behaviors involve providing interpretations of situations that have useful implications for engineers' actions. At the branch level, the effective manager provides direction by helping the branch identify what is important or significant (including customer needs and meeting schedules). For individual engineers, the manager's guidance is described in terms of straight-forwardness, clarity, effective teaching, and helpful feedback. Career development is also singled out as an area of special importance for guiding individual engineers.

(3) ENCOURAGING COLLABORATION AMONG BRANCH MEMBERS.

The third communication function involves the type of communications climate or norms which the manager helps to

establish within the branch. As shown by two behaviors in Table 5, the effective branch manager emphasizes teamwork and cooperation. The value of this sort of behavior has been spelled out in the research literature on organizational conflict (e.g., Thomas, in press), where it is often called "collaboration". In collaboration, workers attempt to satisfy both their own concerns and those of the other person they are dealing with. Behaviorally, this involves clearly stating one's own needs or ideas, listening to the other's needs or ideas, and problem-solving to find a solution that satisfies both people. Collaborating thus tends to result in a greater sharing of information and in superior decision making as compared to alternative ways of interacting (competing, avoiding, accommodating, and compromise). Notice that the combination of communication functions 1 and 2 indicates that effective managers also appear to be collaborative in their own behavior--that is, they are good at both stating their own views and listening to the views of others. In this way, they also appear to provide a model of collaborating for their engineers.

(4) COMMUNICATING THE NEEDS OF THE BRANCH

The branch manager provides a key interface with top management (through the division manager) and with other units. In these contacts, the manager receives information about the needs of customers and top management. However, as one division manager stated, the effective branch manager "cannot be just a conduit" for carrying this information to the branch. The branch and the larger

organization also depend on the branch manager to inform them of the legitimate needs of the branch.

As shown by two behaviors in Table 5, the effective manager is seen as assertively representing the needs of branch by "protecting" and "running interference for" the branch. It seems likely that this assertiveness is combined with listening skills, to take a collaborative form in these contacts. This would parallel the behavior of effective managers with subordinates. However, we have no direct data on this in our study.

IMPLICATIONS FOR NAC

Overall, the engineers' rating of branch manager's effectiveness in Departments 800 and 900 is clearly positive, with mean ratings in the four effectiveness areas ranging from 4.4 for Job Satisfaction to 5.3 for Intrinsic Task Motivation; the Division Managers' overall rating of branch managers' effectiveness was found to be 5.0--all variables scaled from 1 (low) to 7 (high). While the results do not signal problems, in the spirit of continuous improvement, the data provide some direction for increasing the quality of management and thus the quality of performance of the organization.

Ideally, our results will be examined by groups within NAC to discuss their meaning and implications for the support and encouragement of effective management within the engineering divisions and branches. One way that this can be approached is to bring together groups of managers to discuss their interpretation of the results and to identify ways in which the organization can

support the enhancement of behaviors (skills) identified as most strongly related with the targeted effectiveness indicators.

Questions that could be asked of these groups include:

What skills do we currently look for when promoting engineers to managers?

How do we support the development of the skills identified by this study in those engineers who have the potential for promotion?

What are the current organizational mechanisms that support these skills?

What gets in the way of these skills?

By rewarding certain behaviors, do we unintentionally discourage other behaviors that we want to support?

What could be changed to support and enhance managers in these areas?

One obvious area for action is the training of potential and current managers. Here it is interesting to note that, in other data from our study, branch managers reported slightly lower feelings of competence at their jobs than did the engineers they manage (with means of 5.37 versus 5.70, respectively). The findings of our study show that the key skills required for effective management go well beyond the kind of analytic skills in which engineers are trained. To be sure, analytic skills remain important. For example, effective managers help set priorities and provide direction for their branch. Moreover, a number of behaviors in Tables 3 and 5 involve making informed personnel-related decisions--assigning the work equitably, assigning career development opportunities based on individual performance, and assigning tasks and projects based on a subordinate's skills and

limitations. Nevertheless, it is clear that a large number of behaviors in our results involve the sort of interpersonal, people-oriented skills in which engineers have little formal training.

Current training offerings can be compared to the set of competencies identified in this study to find areas that need more emphasis. Our findings help to spell out the set of communication skills most important for effective engineering management, together with more specific behaviors associated with these skill areas. It also provides a description of the managers' work context that helps new or prospective managers make sense of the key role that communication skills play in their effectiveness.

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APPENDIX A
EFFECTIVENESS CHARACTERISTICS FROM THE
PRELIMINARY INTERVIEWS

Characteristics of Effective Engineering Branch Managers provided from the preliminary interviews.

1. Effective Communicator (10)¹
2. Hands off style/not a micro-manager (7)
3. Good people skills (7)
4. Technical expertise--not necessarily detailed (7)
5. Motivates/challenges/gives subordinates energy (5)
6. Accessible to subordinates (5)
7. Provides direction to branch (5)
8. Candidness (4)
9. Possesses backbone/supports people (4)
10. Provides feedback/guidance (4)
11. Able to prioritize/organized (4)
12. Fairness/justice (3)
13. Involved (3)
14. Risk taker (3)
15. In tune with subordinates needs/desires to match with organization's goals (3)
16. Delegates (3)
17. Filter for subordinates from external influences (3)
18. Concerned about subordinates career development (3)
19. Confident in subordinate's abilities (2)
20. Promotes teamwork (2)
21. Trusts subordinates (2)
22. Good planning skills (2)
23. Recognizes potential/limits of subordinates (2)
24. Teacher (2)
25. Pro-active leadership (2)
26. Open/honest with subordinates (2)
27. Participative (2)

Figures in parentheses show number of interviewees mentioning each characteristic. Only characteristics mentioned by at least two people are included in list.

APPENDIX B

CORRELATIONS AMONG EFFECTIVENESS VARIABLES

	1	2	3	4
1 Overall Managerial Effectiveness	---			
2 Intrinsic Task Motivation	.56**	---		
3 Positive Working Climate	.46**	.56**	---	
4 Job Satisfaction	.47**	.83**	.57**	---

* $p < .05$ level of significance

** $p < .001$ level of significance

APPENDIX C

Means¹ & Standard Deviations of
Managerial Behavior Items
As Rated by Engineers (n = 48 branches)

	<u>Managerial Behavior Question</u>	<u>Mean</u>	<u>SD</u>
1.	Has enough technical expertise	4.95	.99
2.	Is willing to take risks	4.59	1.07
3.	Is straightforward and candid	5.42	.90
4.	Is critical of subordinates' efforts	3.08	.77
5.	Shows us how our activities fit into the overall mission of the center	4.08	.87
6.	Promotes teamwork within our branch	4.81	.97
7.	Has a vision of exciting possibilities for our branch	4.53	.94
8.	Is a micro-manager	2.79	.87
9.	Is sensitive to my needs and desires	4.87	.84
10.	Lets us know the significance of what we are doing	4.50	.81
11.	Looks for improved ways of doing things	4.80	.83
12.	Is more strongly focused on meeting deadlines and other requirements than on doing the job well	3.11	.67
13.	Encourages subordinates to participate in making important decisions	4.99	.76
14.	Stands up for subordinates when it counts	5.08	.96
15.	Insists on high standards of performance	4.94	.54
16.	Is accessible to subordinates	5.44	.78
17.	Makes promotion recommendations based on individual performance	4.67	.90
18.	Guides subordinates' career development	4.43	.74
19.	Keeps us on schedule	4.35	.66
20.	Protects the branch from unnecessary hassles and interruptions	4.38	.82

Appendix C (cont.)

21.	Conveys a sense of urgency about meeting the demands placed on our branch	4.64	.69
22.	Assigns tasks and projects appropriately, based on subordinates' skills and limitations	4.67	.80
23.	Encourages subordinates to take risks	4.25	.78
24.	Listens to subordinates	5.44	.81
25.	Assigns career development opportunities based on individual performance	4.40	.73
26.	Encourages us to find ways to improve quality	4.64	.81
27.	Is too busy to talk with subordinates	2.36	.73
28.	Is a "hands-off" manager	4.57	.68
29.	Gives recognition for superior performance	4.94	.85
30.	Treats me with respect	5.77	.68
31.	Keeps us informed of the long-term aims of the organization	4.60	.77
32.	Is aggressive in getting things done	4.78	.86
33.	Emphasizes cooperation between branch members	5.12	.67
34.	Seems to be looking for mistakes we might make	2.78	.88
35.	Gives subordinates an inspiring idea of what is possible	4.14	.69
36.	Emphasizes the importance of meeting customers' needs	5.20	.57
37.	Runs interference for us in dealing with top management and other units	4.72	.85
38.	Pushes ahead in a positive manner	5.15	.70
39.	Assigns work equitably	4.67	.70
40.	Is willing to admit mistakes	5.03	.82
42.	Assigns desirable tasks based on individual performance	4.40	.61
43.	Doesn't "spoon-feed" us with too much guidance on how to do things	5.46	.62
44.	Views mistakes as a learning experience and doesn't hold them against you	5.28	.52
45.	Drops by to talk with me	4.64	.90

Appendix C (cont.)

46.	Worries about what might go wrong	3.92	.79
47.	Is impatient about ideas or questions which deviate from things he/she believes must be done.	3.32	.73
48.	Genuinely cares about subordinates	5.28	.85
49.	Provides a sense of direction for this branch	4.57	.90
50.	Is able to prioritized tasks effectively	4.86	.75
51.	Implements subordinates' ideas	4.76	.67
52.	Keeps us informed of possible surprises/road-blocks	4.80	.75
53.	Complains about what is wrong	2.86	.68
54.	Always seems to be pushing us	3.08	.71
56.	Has confidence in subordinates	5.40	.60
57.	Provides helpful feedback	4.99	.80
58.	Helps us develop ideas	4.63	.84
59.	Knows how to work with others outside our branch to get things done	5.15	.81
60.	Trusts subordinates	5.36	.64
61.	Gives subordinates clear guidance	4.63	.77
62.	Mostly tells us why things <u>can't</u> be done	2.58	.78
63.	Tends to overreact to problems or setbacks	2.69	.68
64.	Is an effective teacher	4.13	.79
65.	Helps us feel good about our achievements	4.91	.82
66.	Gives us credit for our successes	5.16	.76

¹Means are based on a scale of 1-7, 1=low rating, 4=midpoint, and 7=high rating

Note: Items are numbered as in the original questionnaire.

Items 41, 55 and 67 are not included because they are not managerial behaviors.

APPENDIX D

MANAGERIAL BEHAVIORS MOST STRONGLY CORRELATED WITH INTRINSIC TASK MOTIVATION

<u>Managerial Behavior</u>	<u>Correlation Coefficient</u>
1. Runs interference for us in dealing with top management and other units. (MB37)	.67
2. Protects the branch from unnecessary hassles and interruptions. (MB20)	.57
3. Treats me with respect. (MB30)	.57
4. Stands up for subordinates when it counts (MB14)	.56
5. Assigns career development opportunities based on individual performance. (MB25)	.55
6. Assigns tasks and projects appropriately, based on subordinates' skills and limitations. (MB22)	.55
7. Gives recognition for superior performance. (MB29)	.54
8. Guides subordinates' career development. (MB18)	.54
9. Assigns work equitably. (MB39)	.54
10. Keeps us on schedule. (MB19)	.52

Appendix D (cont.)

MANAGERIAL BEHAVIORS MOST STRONGLY CORRELATED
WITH POSITIVE WORKING CLIMATE

<u>Managerial Behavior</u>	<u>Correlation Coefficient</u>
1. Runs interference for us in dealing with top management and other units. (MB37)	.63
2. Assigns work equitably. (MB39)	.60
3. Assigns tasks and projects appropriately, based on subordinates' skills and limitations. (MB22)	.59
4. Implements subordinates' ideas. (MB51)	.57
5. Promotes teamwork within our branch. (MB6)	.54
6. Keeps us on schedule. (MB19)	.54
7. Emphasizes cooperation between branch members. (MB33)	.53
8. Has confidence in subordinates. (MB56)	.51
9. Looks for improved ways of doing things. (MB11)	.51
10. Gives subordinates an inspiring idea of what is possible. (MB35)	.50

Appendix D (cont.)

MANAGERIAL BEHAVIORS MOST STRONGLY CORRELATED
WITH JOB SATISFACTION

<u>Managerial Behavior</u>	<u>Correlation Coefficient</u>
1. Runs interference for us in dealing with top management and other units. (MB37)	.63
2. Assigns career development opportunities based on individual performance. (MB25)	.55
3. Guides subordinates' career development. (MB18)	.51
4. Protects the branch from unnecessary hassles and interruptions. (MB20)	.48
5. Keeps us informed of the long-term aims of the organization. (MB31)	.48
6. Promotes teamwork within our branch. (MB6)	.46
7. Assigns tasks and projects appropriately bases on subordinates' skills and Limitations. (MB22)	.46
8. Implements subordinates' ideas. (MB51)	.46
9. Gives recognition for superior performance. (MB29)	.45
10. Keeps us on schedule. (MB19)	.45

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